

SECTION 13

NOMENCLATURE OF INORGANIC COMPOUNDS

In some ways the naming of inorganic compounds is quite different from those of organic compounds. This section introduces the common everyday names of well known inorganic compounds, and to the more formal systematic rules which have been developed.

Inorganic compound: Compounds of elements other than carbon, but including carbon oxides, carbonates.

The Greek and Latin prefixes given in *section 6* also play an important role in inorganic nomenclature.

Definitive rules for naming inorganic compounds have been agreed on internationally, but as these can lead to rather clumsy names many common names for well known compounds remain in use.

Ionic compounds are called **salts** except where the anion is O^{2-} or OH^- in which case the compounds are called **oxides** and **hydroxides** respectively.

Some polyatomic ions have accepted non-systematic names: NH_4^+ , ammonium; H_3O^+ , oxonium (hydronium) (also often just called hydrogen ion in aqueous solutions); OH^- , hydroxide; NH_2^- , amide; CN^- , cyanide.

In nomenclature, polyatomic ions or molecules are often considered to be made up of a positively charged species, (the charge being indicated by an oxidation number), surrounded by **ligands**, (neutral or negatively charged species), which each have a pair of electrons on the atom bonded (**coordinated**) to the central cation. The names for the two common neutral ligands, water and ammonia, are *-aqua*, H_2O , and *-ammine*, NH_3 , respectively. Negatively charged ligands have the ending *-o*. [e.g. Cl^- , *-chloro*; OH^- , *-hydroxo*; O^{2-} , *-oxo*; CN^- , *-cyano*]. (The International Union of Pure and Applied Chemistry is considering changing the ending of simple anion ligands such as chloride to *-ido*. The examples above would be *chlorido*, *hydroxido*, *oxido*, *cyanido*.)

A brief outline of the definitive rules and traditional naming is given below. The examples should clarify the rules.

Systematic naming rules

- 1 The cation has its name unmodified (e.g. the name of the element).
- 2 If the anion is monatomic its name is modified to end in *-ide*.
- 3 If the anion is polyatomic its name is modified to end in *-ate*.
- 4 When oxidation states are to be indicated they are shown by Roman numerals in brackets following the name of the element.
- 5 The number of atoms or ligands attached to the central atom is denoted by Greek prefixes.

Examples:

KBr	is potassium bromide	rules 1,2
Ca(OH) ₂	is calcium hydroxide	rule 1
NaClO ₃	is sodium trioxochlorate(V)	rules 1,3,4,5
FeCl ₃	is iron trichloride or iron(III) chloride	rules 1,2,4,5
Cu(NH ₃) ₄ F ₂	is tetraamminecopper(II) fluoride	rules 1,2,4,5
NH ₄ BF ₄	is ammonium tetrafluoroborate(III)	rules 3,4,5

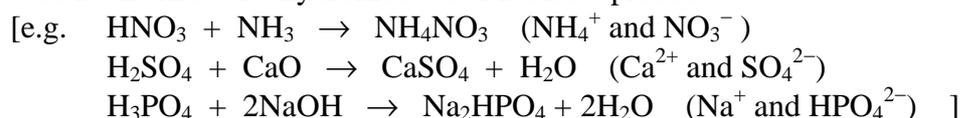
The traditional names for the third and fourth examples are sodium chlorate and chromic chloride respectively. The following points concern this more traditional method of naming:

- The endings *-ous* and *-ic* are used for cations of elements existing in only two oxidation states, *-ous* representing the lower state.
- The ending *-ite* is used to indicate the oxoanion of oxidation state lower than the common one which ends in *-ate*. An even lower one is *hypo.....ite*, and one higher than *-ate* is *per.....ate*.
- The Latin or Greek stem is used for elements whose symbols come from those languages.

Examples:

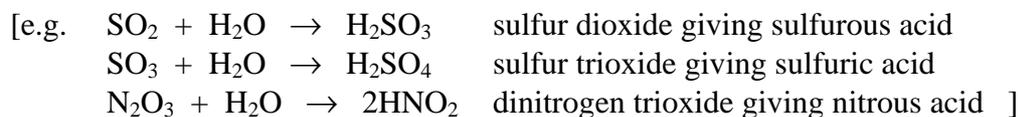
FeCl ₂	is ferrous chloride	FeCl ₃	is ferric chloride
SnCl ₂	is stannous chloride	SnCl ₄	is stannic chloride
KNO ₂	is potassium nitrite	KNO ₃	is potassium nitrate
Na ₂ SO ₃	is sodium sulfite	Na ₂ SO ₄	is sodium sulfate
NH ₄ ClO	is ammonium hypochlorite	NH ₄ ClO ₂	is ammonium chlorite
NH ₄ ClO ₃	is ammonium chlorate	NH ₄ ClO ₄	is ammonium perchlorate

Salts can be thought of as the product of a reaction between an acid and a base. Where the base is an oxide or a hydroxide water is also a product.



The oxoacid corresponding to an *-ate* anion is called the *-ic* acid; to an *-ite* anion the *-ous* acid. HClO is hypochlorous acid; HClO₂ is chlorous acid; HClO₃ is chloric acid; HClO₄ is perchloric acid. (**Per** is also used in two other ways; as shorthand for the peroxy group, -O-O- and for organic compounds where all hydrogens attached to carbon have been replaced by a halogen [e.g. perfluoroethane C₂F₆]. Thus one must look at the context of the term to determine the meaning.) For salts of polyprotic acids in which the anions still have hydrogen atoms attached, the word hydrogen is written before the anion. Thus NaH₂PO₄ is sodium dihydrogenphosphate, Na₂HPO₄ is sodium hydrogenphosphate, and NaHCO₃ is sodium hydrogencarbonate. In the past the word hydrogen in salts of diprotic acids was often replaced by *bi-* [e.g. NaHCO₃ sodium bicarbonate], but it is no longer approved nomenclature.

Most of the covalent oxides are named according to the relative number of atoms of the element and oxygens [e.g. SO₂, sulfur dioxide; SO₃, sulfur trioxide; N₂O₃, dinitrogen trioxide]. Oxoacids may be thought of as coming from the hydrolysis of the oxide containing the element in the same oxidation state.



Acid anhydride: The product from removing water from an acid. (**Anhydride**, a substance formed by removing the elements of water from a compound.) [e.g. the oxides in the above three reactions with water.]

N₂O and NO, two well known oxides of nitrogen, have the common names nitrous oxide and nitric oxide respectively. However they are not the anhydrides of nitrous acid and nitric acid. This emphasises the point that language of chemistry has developed historically and, as in any language, there are pitfalls for the beginner.

EXERCISES

Deduce the common names for the following compounds from the names given for related compounds.

1. Cu₂SO₄ CuSO₄ is cupric sulfate
2. Fe₂(SO₄)₃ FeSO₄ is ferrous sulfate
3. H₃PO₃ H₃PO₄ is phosphoric acid
4. K₂MnO₄ KMnO₄ is potassium permanganate